US Army Corps of Engineers®

Industrial Energy and Process Optimization

Industry Workshop

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Report Documentation Page

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Overview

- Problem Statement
- Solutions / Approach
- Workscope / Methodology
- Tools
- Illustrative Examples
- Project Team & Timeline

Problem Statement

- The current Army industrial Base consists of facilities and installations that produce ammunition, store munitions, manufacture components, and maintain and overhaul equipment;
- Many of these facilities and their mechanical and energy systems are beyond their useful life, they were designed with littel regard to energy conservation and systems reliability;
- Specific feature of many Army industrial facilities is that they are operating at significantly reduced production capacities. However, this is not addressed by production processes layout and energy systems design and operation;
- DoD installations are unable to quantify and control energy consumption at industrial facilities or by their processes.

Problem Statement (Continued)

- Most of AMC industrial processes are unique and are not addressed by the DOE Office of Industrial Technologies Industries of the Future Program and R&D efforts;

- Holistic approach to energy optimization in industrial facilities, which includes industrial processes, building envelope and energy/mechanical systems related measures was and is not addressed by any existing program;

- U.S. AMC transformation White Paper approved by
- General Paul Kern (July 2003), calls for adoption of "Lean Thinking" philosophy at AMC industrial facilities through "improved use of space, reduced process times, waste, and costs, enhanced customer satisfaction, increased efficiency, and saved Army precious resources".

Solutions/Approach

- Determine Army requirements and user needs related to industrial facilities;
- Benchmark critical industrial processes for energy consumption and other production costs to support Army transformation strategy, which includes process integration, consolidation and cost reduction;
- Minimize energy loads and optimize operation of building energy systems;
- Develop a suite of tools for DoD industrial base to lower production costs through process and energy optimization, while operating at reduced and full capacity levels;
- Demonstrate these tools through several PO assessments and show-cases at selected installations;
- Train installation energy managers and their contractors in the use of of this suite of tools;
- Assist AMC (where needed) in transformation efforts.

Scope of Work and Methodology

- Army needs will be identified through site visits and a workshop;
- Consensus process optimization and energy assessment tool will be developed through the thorough analysis of material flows and the overall building/process air and heat balances; processes will be benchmarked to the state-of-the-art with a similar production levels; energy analysis will include such areas as building envelope, process encapsulation systems, HVAC and other mechanical systems;
- Process optimization will be addressed through production consolidation, flexibility and scalability;
- Computer-based tool will provide strategies/measures allowing for reduction/elimination of contaminant emissions inside the building, which include chemical and mechanical approaches; analytical (CFD) and experimental studies will result in templates for optimized designs and performance characteristics of process exhaust systems;

Scope of Work and Methodology (Continued)

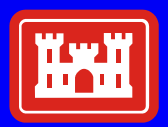
- State-of-the-art technologies and energy saving measures screened for applicability and LCCA for representative climatic conditions and energy costs, will provide a data base for the Guide/Adviser "Energy saving technologies and measures for industrial building retrofits";
- Developed methodologies and tools will be tested and demonstrated through process optimization assessments at selected installations;
- Installation energy managers and their contractors will be trained in the use of the developed suite of tools.

Process and Energy Assessment Methodology

- Increase in energy efficiency will need increased number of high quality energy audits/surveys;
- Cost effective energy saving measures can be found only when trained energy auditor is involved and energy audit/survey is conducted using consistent approach;
- To fulfill the needs of the federal sector a consensus process and energy analysis methodology will be compelled from the state-of-the-art international experiences and result in the ***"Energy Assessment Guide/Adviser for Energy Managers and ESCOs."***

Process and Energy Assessment Methodology

- Collect detailed information on energy assessment methodology and tools available: the information shared by the Industry Workshop (Chicago, October 7 and 8) participants showed the variety of different methodologies allowing for analysis of energy savings in buildings.
- Compare and contrast these methodologies and summarize the results in a form of consensus "*Pprocess and Energy Assessment Guides /Advisers for Energy Managers and ESCOs"* for Industrial buildings"



Energy Adviser "Energy Saving Technologies and Measures for Industrial Building Retrofits"

- Identify promising energy saving technologies/measures (current, proven, well-known or underused) and measures allowing for increased systems security and reliability
- Identify tools/computer programs for technology/measures screening
- Identify representative screening conditions (building type, standard climatic conditions, energy costs, etc)
- Conduct screening
- Summarize the results by categories (building envelop related measures, internal load reduction, HVAC and energy systems optimization, etc.), indicate technologies providing increased systems reliability and security
- Present the information in the user-friendly format of the *Guide to "Energy Saving Technologies and Measures for Building Retrofits"* with pros and cons for each measure.
- The format of the document may be similar to the Annex 36 Energy Adviser (developed for educational buildings).

Examples of Energy Saving Technologies/ Measures

- Building envelope optimization (e.g., building envelop insulation, caulking and weather-stripping, exterior window shading, vestibules, air curtains, etc);

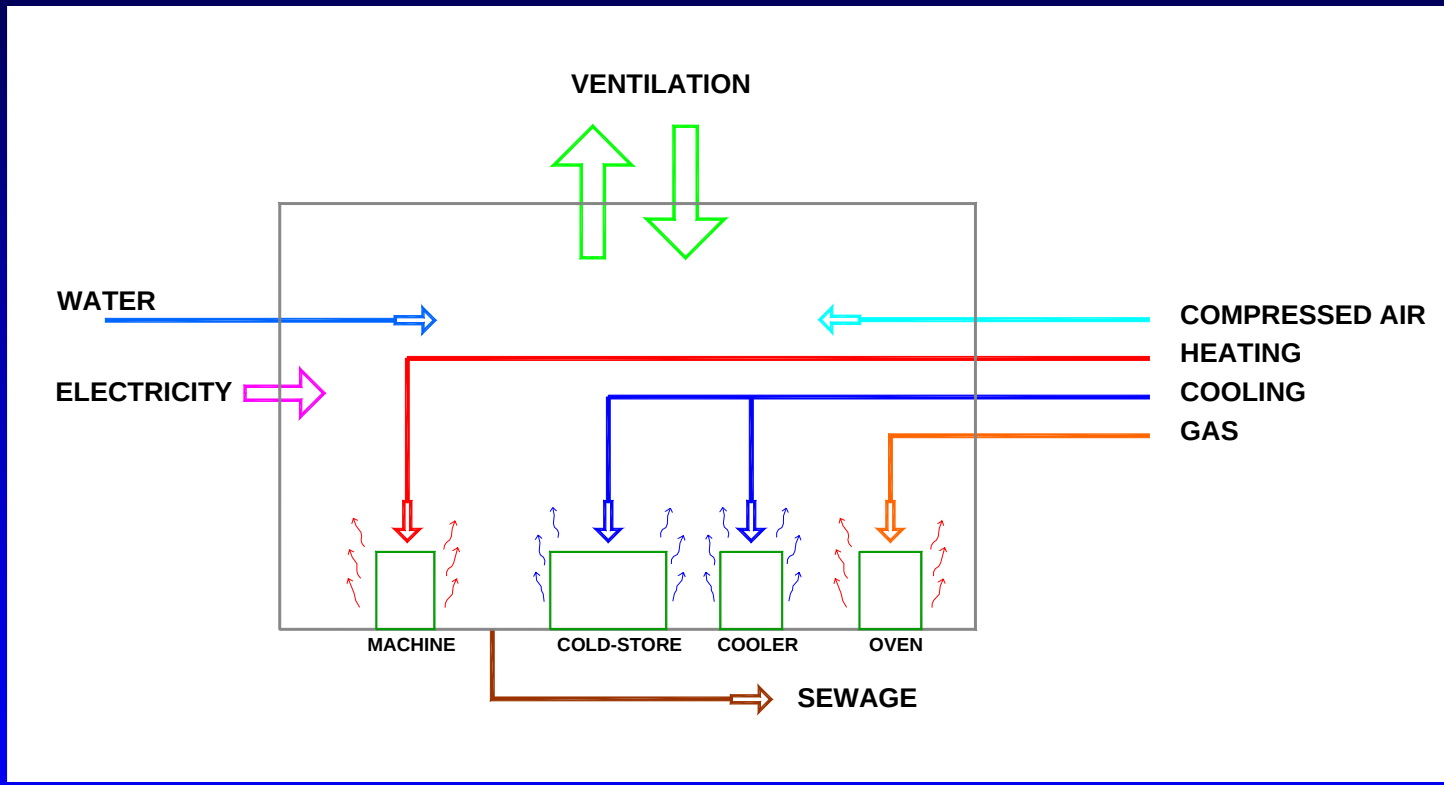
- Internal load reduction (e.g., lighting, motion sensors, use of EnergyStar appliances, process encapsulating, optimization and control, compressed air systems, etc.)

- HVAC system related (e.g., separation of V and HAC systems, hybrid ventilation, VAV systems, efficient air distribution strategies, AHU process optimization, BMS, VFD, high efficiency motors, chillers and furnaces, waste heat recovery, hybrid ground and air source heat pumps, etc.)

Summary of Examples

Industrial Building Energy Components

- Heating
- Cooling
- Ventilation
- Compressed air
- Water
- Sewage
- Process
- Lights



Industrial Building Heating, Cooling and Ventilating Systems

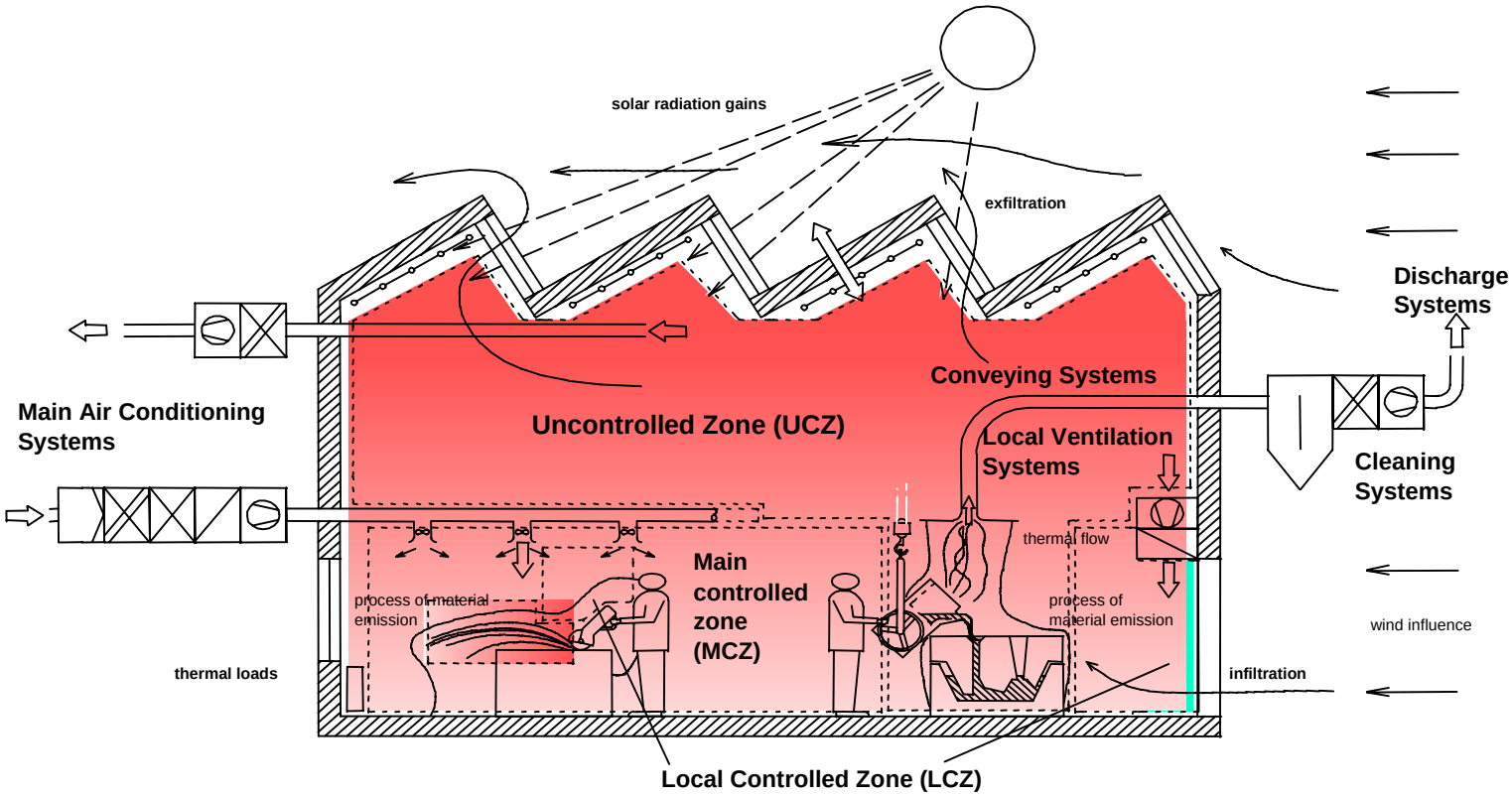
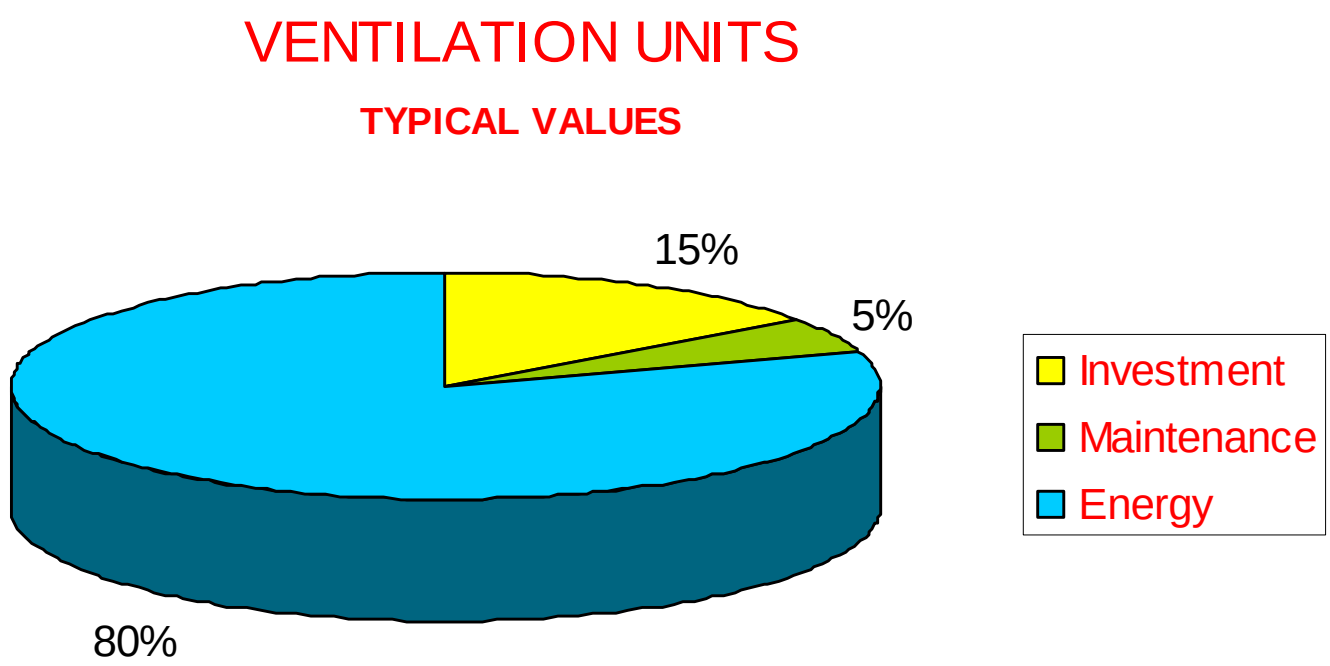


Figure 1. Industrial Air Technology

Reproduced from Industrial Ventilation Design Guidebook

Heating, Cooling and Ventilation Life Cycle Costs

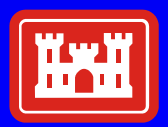


Measures Allowing for Reduction of Heating/Cooling and Moisture Loads, and Occupational Exposure to Contaminants

- Building related measures
- Process related measures
- Ventilation
  - Local exhausts
  - Local supply
  - Dilution (general supply and exhaust)

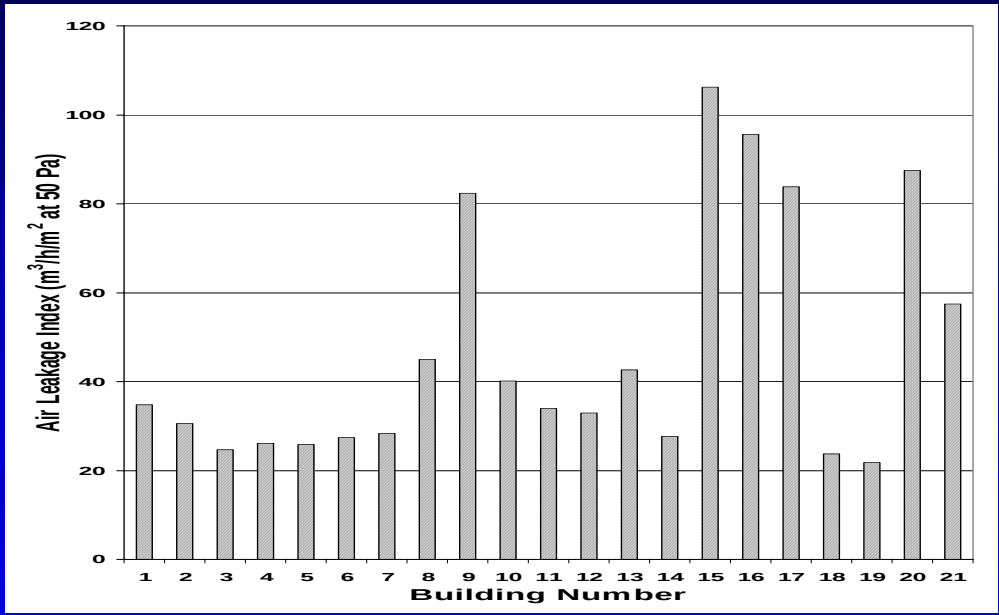
Building Related Measures
Examples (continued)

- Add vestibules or revolving doors to primary exterior personnel doors;
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned building zones;
- Use dock seals at shipping and receiving doors;
- Select proper location of outside air intakes and contaminated air exhausts;
- Use landscaping and building orientation to advantage.

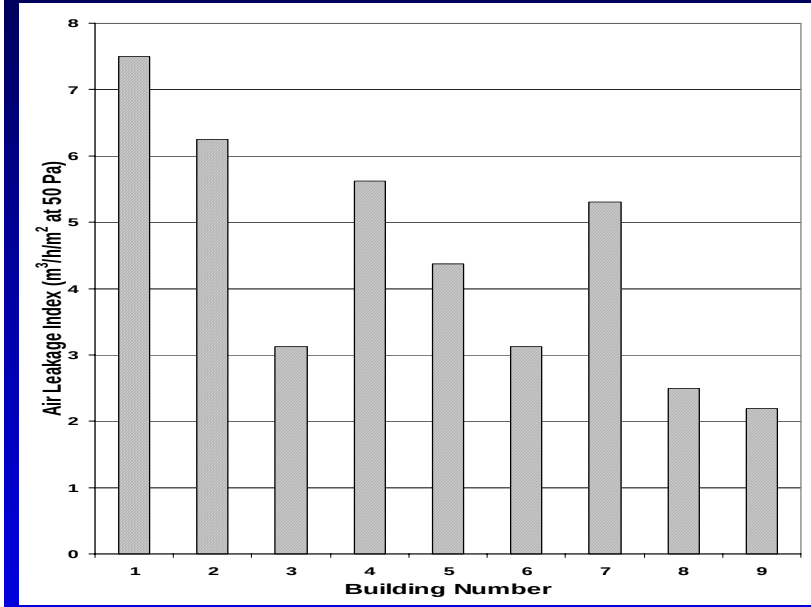


Building Related Measures

Energy Implications of Excessive Air Leakage



Air leakage indices of UK Industrial Buildings

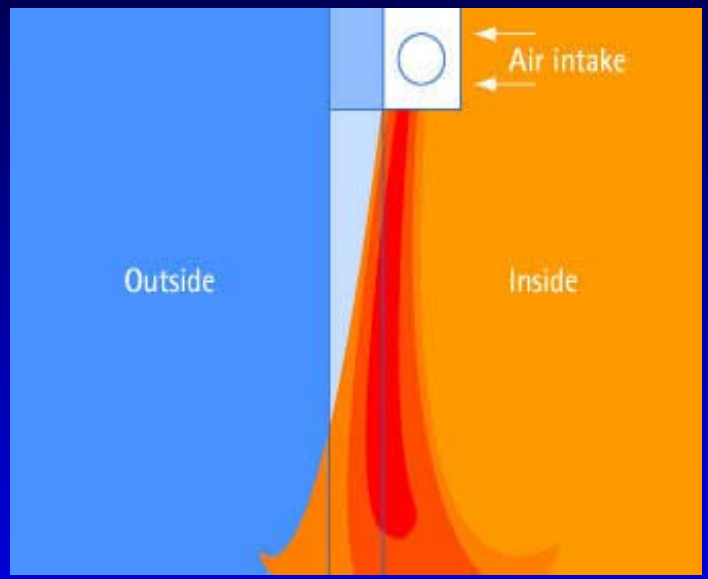


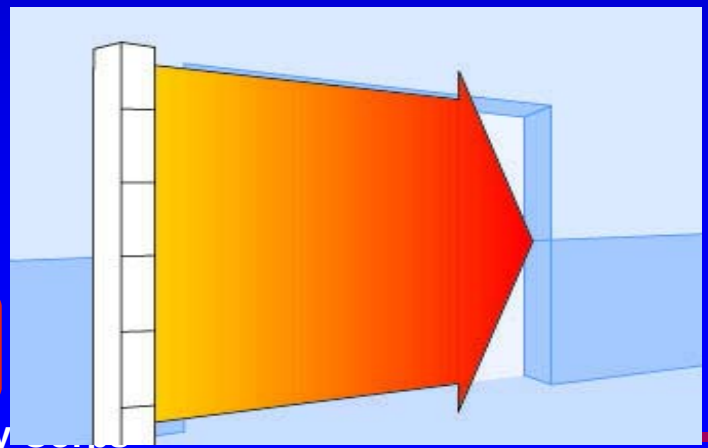
Air leakage indices of Swedish Industrial Buildings

According to BRE, potential annual energy savings for 10,000 m2 industrial building due to an air leakage index reduction from 20 to 5 $m^3/h*m^2$ at 50 Pa will be 165,000 kWh

Building Related Measures

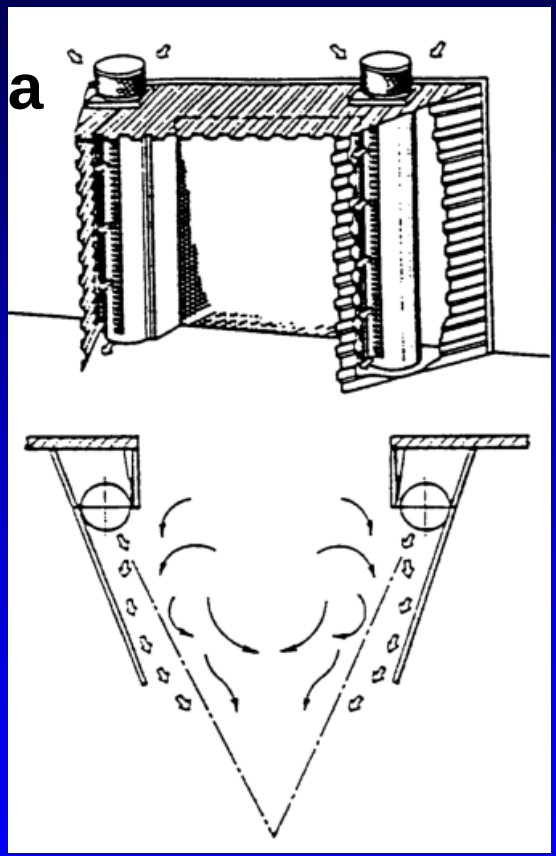
Typical Recirculating Vertical Shutter-Type Air Curtains





Building Related Measures

Cold Air Curtains with a Lobby



a - schematic
b - general view
c - air distribution duct with multiple nozzles

Building Related Measures

Air Locks at the Gate

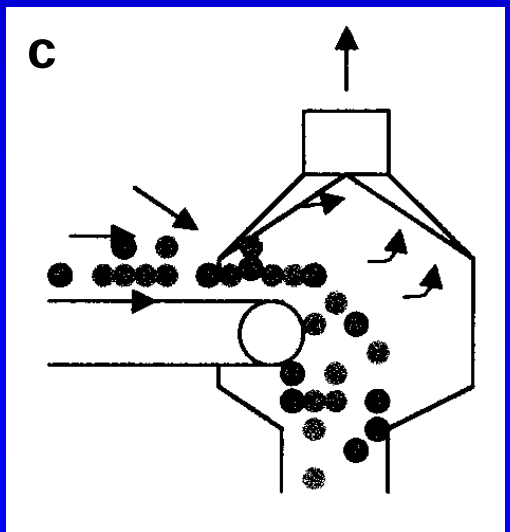
The building is protected from then outdoor air by two sequentially installed gates with an enclosed space (“air lock”). There is only one gate open at a time to let a vehicle in or out the building. After the vehicle enters the “”air lock” the first gate closes and the second one opens.

Process Related Measures
Examples

- Select processes with lower contaminant emission rates (e.g., spot welding Vs. arc welding, application of low emission coolants in machining processes;
- Use raw materials with lower emission rates;
- Use controlled process enclosures to reduce emission of heat and airborne contaminants generated by the process into the building;
- Enclose transfer lines and containers to reduce residual contaminant emission.

Process Related Measures

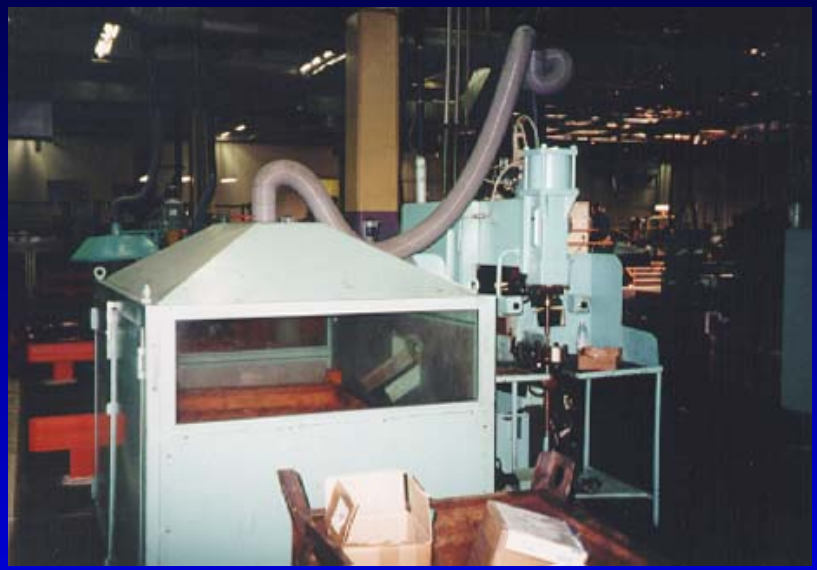
Process Encapsulation



a - machining process enclosure with an oil mist control system ; **b** - canopy hood with a plastic curtain enclosing the robotic welding area; **c** - enclosed loading point from a conveyer belt (Reproduced from SSOE).

Process Related Measures

Enclosures Reducing Residual Contaminant Emission

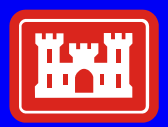


Enclosure over a containers with welded small parts. Exhaust from the enclosure controls residual weld fumes.

An overhead hood with a perimeter plastic curtain above the conveyor transporting welded parts. The exhaust from the enclosure evacuates residual weld fumes.

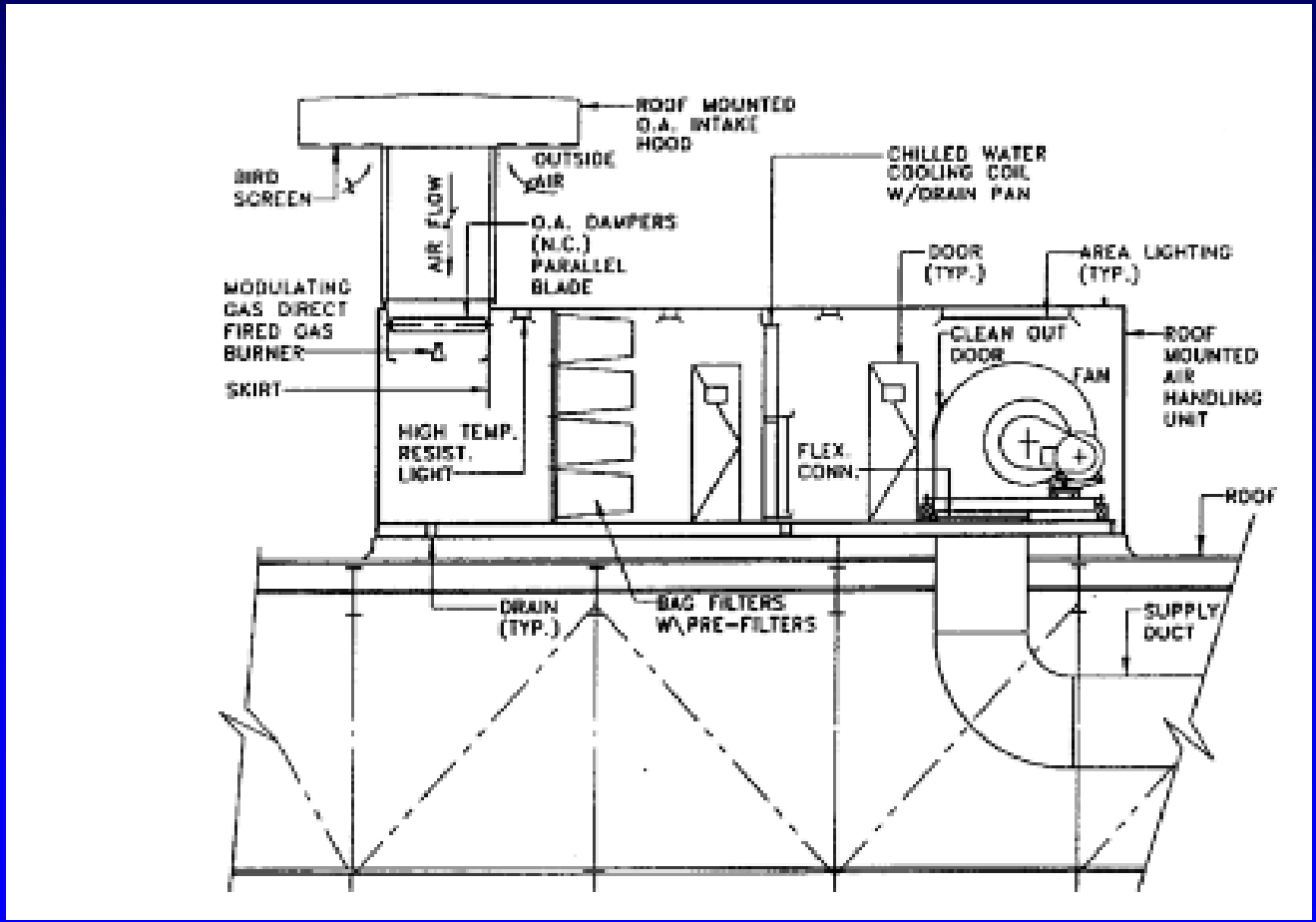
Ventilation Systems Related Measures
Examples

- Consider local exhaust built-in or around the process at the production cell design stage;
- Flexible HVAC systems designed to respond to changes in
  - production level,
  - processes
  - use of the building
  - climatic conditions
- Thoroughly calculate the required outside/supply airflow rates;
- Optimize air supply and exhaust strategies to control working environment;
- Design zonal or modular supply systems for shops with non-uniform loads;
- Select high performance ventilation equipment, fans, motors, heat exchangers, etc.



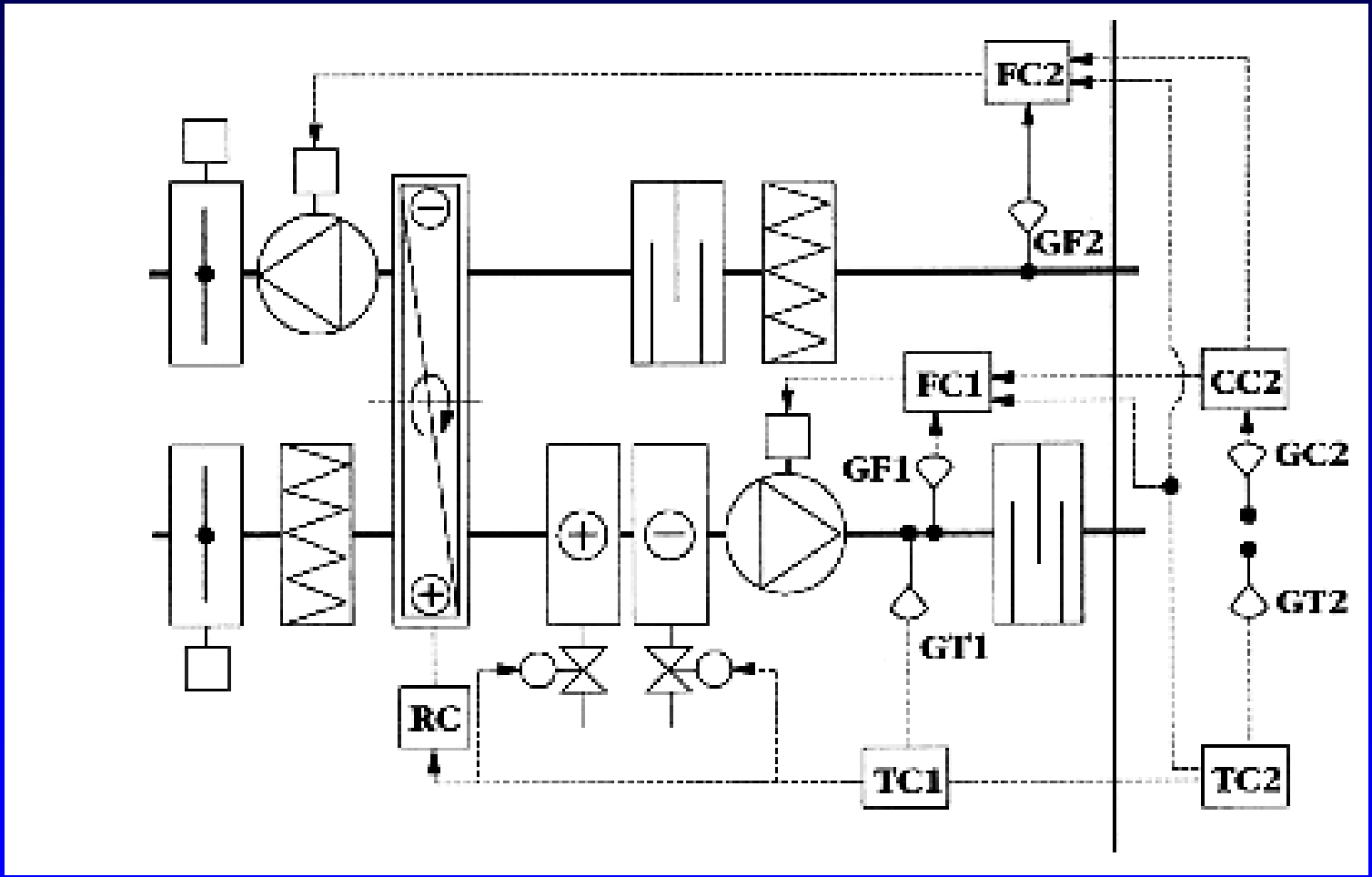
Ventilation Systems Related Measures

Roof-Top Mounted AHU with a Chilled Water Cooling Coil and a Direct Fired Gas Burner



Ventilation Systems Related Measures

Basic Variable Air Volume HVAC System with Energy Recovery



Ventilation Systems Related Measures

Example of the Centralized VAV HVAC System with Energy Recovery

Roof-Top Air Handling Unit

Supply air bag filters and a heat recovery weal

Ventilation Systems Related Measures

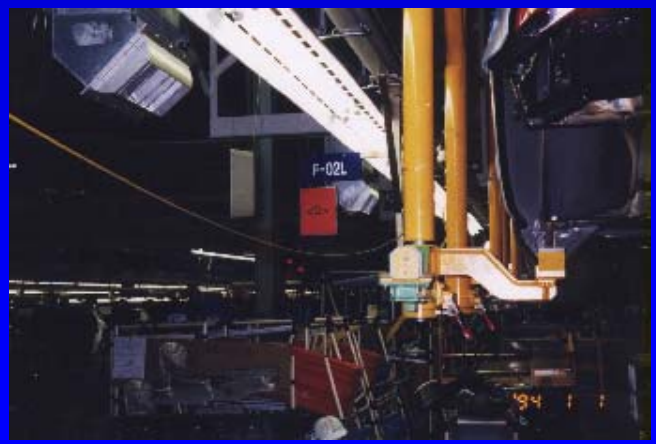
Energy "Waste" from Air-Cooled Compressors

Ventilation Systems Related Measures

Building, Occupied Zone and Work Place Thermal Comfort and IAQ Control

Total shop volume control

Occupied zone control

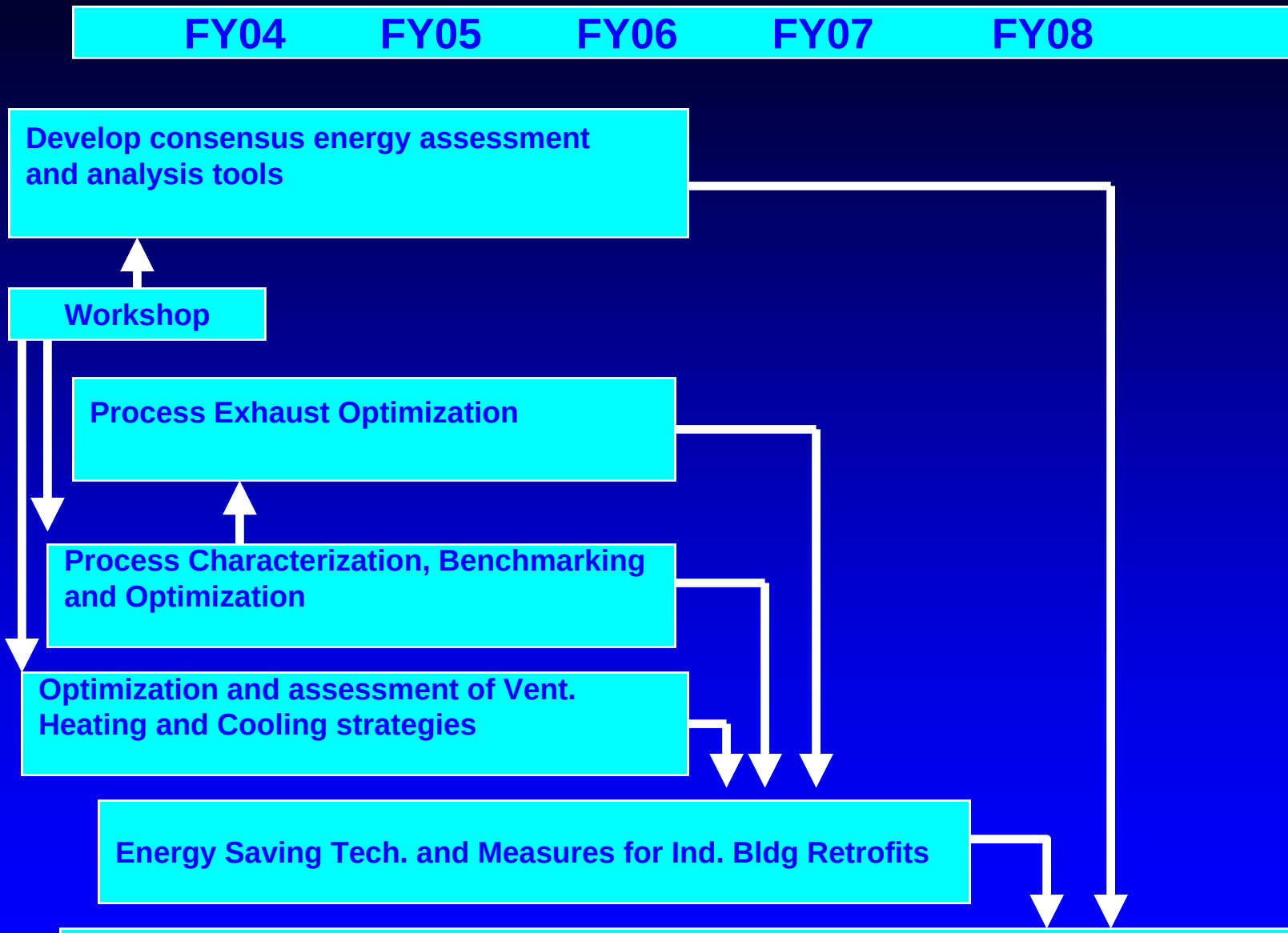


Individual work place control

Project Team and Collaboration

- The project will be executed by the USACE ERDC-CERL CFE, CNE and CFM teams using a combination of research and reimbursable funds in collaboration with DOE OIT, OBT and FEMP Program, ASHRAE and through international collaboration via IEA DSM and ESBCS Programs;
- ORNL, LBNL and DOE IOT energy assessment centers (e.g., Rutgers, Chicago) based on the mix of DOD and DOE OIT funds?
- Fraunhopher Institute of Building Technologies (Germany) and University of Stuttgart (German national funds via IEA Program)
- VTT (Finnish national funds via IEA Program)
- ASHRAE – TC 7.6 Working Group
- Consultants from USA and Sweden will participate through reimbursable projects

Timeline



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Questions, Comments ??

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